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NOTES ON JAPANESE PROTOZOA
WITH FIGURES AND DESCRIPTIONS OF NEW AND RARE SPECIES

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The fresh-waters of Japan afford a wonderful opportunity for the enthusiastic microscopist. Conditions under which simple organisms thrive are not wanting anywhere in that country. Flooded rice fields of the lowlands, cool mountain streams and innumerable lakes, large and small, are teeming with low plant and animal forms.

To what extent systematic study of the microscopic fauna and flora of the waters of Japan has progressed, under the direction of the eminent biologists of that country, the writers of this article are not able to state.

With a view of determining the species of Protozoa characteristic of Japan and comparing them with the American forms, microscopic studies were carried on by C. H. Edmondson during July and August, 1912, in various parts of the main island. Beginning with Kobe, observations were made through the central and eastern sections of the country and as far north as Lake Chuzenji.

Material was gathered from rice fields, small pools, streams and lakes. Collections were made from the following large lakes: Lake Biwi, altitude above sea level 328 ft.; Lake Hakone, altitude 2,378 ft.; Lake Chuzenji, altitude 4,375 ft. Since the survey covered a wide territory with considerable variation in local conditions as well as in altitude, the list of species embodied in this brief report may well represent the characteristic unicellular fauna of the entire country. The portion of this article concerned with Rhizopoda is largely a result of the work of R. H. Kingman, a student of zoology,

who identified and studied many forms from preserved material. By comparing the list which follows with numerous local records of observers in America and other parts of the world one sees some added evidence of the wide distribution of many species of Protozoa.

The accompanying figures, prepared by Mr. Kingman from permanent mounts, represent new, or rare species of Rhizopods or forms showing considerable variation.

Phylum **PROTOZOA**: Subphylum **SARCODINA**:

Class RHIZOPODA Subclass AMOEBEA

Order GYMNOAMOEBA

Family Amoebidae

Amoeba Ehrenberg. *A. proteus* Leidy; *A. guttula* Duj.; *A. sphaeronucleus* Greef; *A. striata* Penard; *A. radiosa* Ehr.; *A. saphrina* Penard.

The species of this genus were not common in any locality. Material from Myoho-in Temple grounds, Kyoto, furnished the best examples. Large individuals of *A. radiosa* were taken from Lake Hakone.

Hyalodiscus Hertwig and Lesser. *H. rubicundus* H. and L.

But one individual was observed. A very typical form, reddish-brown in color. From a rice field, Kyoto.

Arcella Ehrenberg. *A. vulgaris* Ehr.; *A. discoides* Ehr.; *A. costata* Ehr.; *A. arenaria* Greef.

Of the above species *A. vulgaris* is the more widely distributed in Japan. Lake Chuzenji and the region of Kyoto furnished the best material.

Centropyxis Stein. *C. aculeata* Stein.

Found in all localities. Very abundant in Lake Hakone. Great variation in size occurs in this species and some very large forms were observed.

Pixidicula Ehrenberg. *P. cymbalum* Penard.

A species rarely observed. Found in material from Lake Hakone.

Lecquereusia Schlumberger. *L. spiralis* Ehr.; *L. modesta* Rhumbler.

These two species are widely distributed in Japan, the former being much more abundant. In the typical *L. spiralis* the aperture

is usually directed obliquely toward one side with a prominent hump at the outer base of the neck. In the common form in Japan the aperture is directed almost straight forward, in very rare cases there being a slight prominence at the base of the neck. Common in Lake Hakone. Typical examples of *L. modesta* were found in lakes on Mt. Rokkozan.

L. epistomium Penard, a common species of the high lakes of Colorado, was not observed in Japan.

Diffugia Leclerc. *D. pyriformis* Perty; *D. lobostoma* Leidy; *D. constricta* Leidy; *D. acuminata* Ehr.; *D. tuberculata* Wallich; *D. lebes* Penard; *D. bacilliarum* Perty; *D. elegans* Penard.

Of the species of *Diffugia* in Japan, *D. elegans* is apparently the most common. It is widely distributed and shows a great range of variation. *D. lebes*, not uncommon in some of the lakes of Colorado, was observed but once, in material from the bottom of Lake Hakone.

Pontigulasia Rhumbler. *P. spectabilis* Penard.

But one individual observed. From Lake Hakone. A very typical form.

Quadrulella Cockerell. *Q. symmetrica* Schultze; *Q. symmetrica* var. *curvata* Wailes.

Very typical forms of the species were taken from shallow lakes on Mt. Rokkozan. The variety, observed but once, was found in Lake Hakone.

Nebela Leidy. *N. collaris* Leidy; *N. crenulata* Penard; *N. hippocrepis* Leidy; *N. triangulata* Lang.

In the material collected in Japan species of *Nebela* were very rare.

There can be no reason to believe, however, that the genus is not well represented in that country. One individual of the rare species, *N. hippocrepis*, was found in material from Mt. Rokkozan. In the ooze from the rocks along the shore of Lake Hakone and from the border of a shallow lake on Mt. Rokkozan was found a species which is here listed under the name *N. triangulata* Lang.

The Japan species resembles, in some particulars, *Nebela bipes* Carter, as described in Clare Island Survey, Part 65, by Wailes

and Penard, and may represent an intermediate form between *N. triangulata* and *N. bipes*.

In the Japan form the shell is very transparent, compressed, irregular in outline with the fundus region inflated in an asymmetrical manner. The aperture is slightly oval.

Great variation exists in the form of the shell and in the arrangement of the plates. In some the plates are circular or oval, distinctly separated from each other with the ground substance of the shell intervening. In others the plates are closely crowded together and very irregular in outline, while in some the plates are regular in outline but distinctly overlap each other.

The irregular inflation of the fundus is a characteristic feature. Usually the posterior lateral borders are expanded into lobes of variable size. In some these prolongations are pointed as in *N. bipes*, but more often they are blunt or rounded. Occasionally the fundus is truncated posteriorly, sometimes it is strongly concave. The extensions of the fundus are seldom uniform on the two sides of the shell and are never the same in two individuals. Usually the narrow view of the shell presents an irregular outline. The compression of the shell is seldom uniform, but is always stronger at the fundus border.

The size of the Japanese form ranges from 80 to 100 μ in length, including the prolongations of the fundus; from 60 to 80 μ in breadth of fundus and from 28 to 60 μ in the long diameter of the aperture.

No living individuals were observed.

Heleopera Leidy. *H. picta* Leidy.

Material from Mt. Rokkozan furnished the only species of the genus observed. Under high power the plates are seen to be circular, slightly overlapping. Little foreign material is attached to the shell.

Phryganella Penard. *P. hemisphaerica* Penard.

Frequently observed in many localities.

Campascus Leidy. *C. dentatus*, sp. nov.

In 1877 Leidy discovered *Campascus cornutus* in China Lake, Wyoming, at an altitude of 10,000 feet. Apparently the species has not been observed since that time.

More recently Penard described two species of the genus, *Campascus triqueter* and *Campascus minutus*, from the deep lakes of Switzerland. In both species described by Penard the fundus is without the horn-like prolongations of the form observed by Leidy. *Campascus minutus* was reported by Wailes in 1912 from the New York water-supply drawn from Croton Lake Reservoir.

The form under consideration, which is apparently a new species, was found in the ooze taken from the rocks along the shore of Lake Hakone, Japan, in August, 1912.

The description follows: Shell of yellowish, chitinous material similar in general outline to *Campascus cornutus*. Under high power the shell has the appearance of being distinctly punctate. In some individuals the punctae are arranged in a regular diagonal manner, in others there is no regularity about the arrangement. In no specimens examined can outlines of plates be detected even with the oil immersion lens.

The neck is short and sharply bent, nearly at right angles to the long axis of the shell. The circular aperture is bordered by a thin delicate membrane of approximately 4μ in breadth.

A number of short, blunt, tooth-like prolongations are present on the posterior border of the fundus. From three to seven of these processes are usually present. They vary in size and when numerous give an irregular, crenulated appearance to the posterior edge of the fundus, when the broad side of the shell is viewed.

In Leidy's species the two horns are directed laterally and posteriorly, their tips not projecting beyond the posterior border, giving the fundus a rounded outline when the narrow side of the shell is observed. In this species the teeth-like points are directed backward and project beyond the border, giving the fundus the appearance of terminating in a spine when the narrow side of the shell is seen.

Leidy records the size of *Campascus cornutus* as ranging from 0.112 mm. to 0.14 mm. long by 0.18 mm. broad.

This species of Japan is much smaller. The length of the shell, including the spines and the collar about the aperture, ranges from 60 to 80μ . Breadth of fundus from 50 to 66μ .

Greatest thickness, narrow view, 28μ . Aperture 12μ in diameter.

The living organism was not observed.

Paulinella Lauterborn. *P. chromatophora* Lauterborn.

Empty shells of this very minute form were found in material from the bottom of Lake Hakone and also from shallow lakes on Mt. Rokkozan. The shell is composed of five longitudinal rows of plates and possesses a short neck. The Japan form is very typical.

Cyphoderia Schlumberger. *C. ampulla* Ehr.; *C. ampulla* var. *papillata* Wailes.

The species is very common in Lake Hakone and was found in other localities. Considerable variation in size and also in the arrangement of plates occurs. The plates are usually placed in diagonal rows, but this regularity is not always maintained.

The variety was observed but once and that in material from Lake Hakone.

Sphenoderia Schlumberger. *S. lenta* Schiumb.

Very widely distributed and also very common in Japan. The only species of the genus to be determined.

Euglypha Dujardin. *E. alveolata* Duj.; *E. brachiata* Leidy; *E. filifera* Penard; *E. laevis* Perty; *E. ciliata* Ehr.; *E. armata* Wailes.

A few species of this genus are very abundant in Lake Hakone as well as in other localities. Two species, *E. filifera* and *E. ciliata*, were rarely observed, the others mentioned are common.

Assulina Ehrenberg. *A. seminulum* Ehr.

Observed in material from Kyoto. A very typical form, chocolate-brown in color.

Plagiopyxis Penard. *P. callida* Penard.

Identified in material from Kyoto. Not common.

Trinema Dujardin. *T. enchelys* Ehr.; *T. lineare* Penard; *T. campfanatum* Penard.

The genus represented by *T. enchelys* is very common in many localities. The other two species were rarely observed.

Class ACTINOPODA Subclass HELIOZOA

Order APHROTHORACIDA

Actinophrys Ehrenberg. *A. sol* Ehr.

Observed in great abundance at Kyoto; rarely seen in other localities.

The following list is a record of the species of Mastigophora and Infusoria identified in material taken from the fresh waters of Japan. Flagellates and ciliates are very abundant in that country, as elsewhere, and the small number of species here listed indicates brevity of observation rather than any dearth in protozoan fauna. The remarkable thing to be noticed is the identity of the Japanese forms with our common American species.

Subphylum MASTIGOPHORA:

Class ZOOMASTIGOPHORA

Order HETEROMASTIGOPHORA

Notosolenus Stokes. *N. orbicularis* Stokes.

Anisonema Dujardin. *A. acinus* Duj.

Order MONADIDA

Anthophysa Bory d. St. Vincent. *A. vegetans* Müll.

Order EUGLENIDA

Euglena Ehrenberg. *E. viridis* Ehr.; *E. deses* Ehr.; *E. acus* Ehr.

Phacus Dujardin. *P. pleuronectes* Müll.; *P. longicaudus* Ehr.

Trachelomonas Ehrenberg. *T. hispida* Stein; *T. volvocina* Ehr.;
T. armata Stein.

Astasia Ehrenberg. *A. trichophora* Ehr.

Distigma Ehrenberg. *D. proteus* Ehr.

Subphylum INFUSORIA:

Class CILIATA

Order HOLOTRICHIDA

Coleps Ehrenberg. *C. hirtus* Ehr.

Lacrymaria Ehrenberg. *L. olor* Müll.

Lionotus Wrzesniewski. *L. fasciola* Ehr.

Dileptus Dujardin. *D. gigas* C. and L.

- Chilodon Ehrenberg. *C. cucullulus* Müll.
 Nassula Ehrenberg. *N. oronata* Ehr.
 Loxocephalus Ehrenberg. *L. granulatus* Kent.
 Cinetochilum Perty. *C. margaritaceum* Ehr.
 Frontonia Ehrenberg. *F. leucas* Ehr.
 Paramaecium Müller. *P. caudatum* Ehr.; *P. bursaria* Ehr.
 Cyclidium Ehrenberg. *C. glaucoma* Ehr.
 Pleuronema Dujardin. *P.* sp. (undetermined).

Order HETEROTRICHIDA

- Spirostomum Ehrenberg. *S. ambiguum* Ehr.
 Stentor Oken. *S. caeruleus* Ehr.; *S. polymorphus* Ehr.
 Gyrocoris Stein. *G. oxyura* Stein.

Order HYPOTRICHIDA

- Oxytricha Ehrenberg. *O. pellionella* Müll.
 Stylonychia Ehrenberg. *S. notophora* Stokes.
 Euplotes Ehrenberg. *E. charon* Müll.
 Aspidisca Ehrenberg. *A. costata* Duj.

Order PERITRICHIDA

- Vorticella Linnaeus. *V.* sps.

A number of undetermined species were observed.

- Cothurnia Ehrenberg. *C.* sp. (undetermined).

Class SUCTORIA

- Sphaerophrya Claperède and Lachmann. *S. magna* Maupas.
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EXPLANATION OF FIGURES

PLATE III

- Fig. 1, *Lecquereusia spiralis* Ehrenberg; \times 272. From Lake Hakone.
 Fig. 2, *Lecquereusia spiralis* Ehrenberg; \times 257. From Lake Hakone.
 Fig. 3, *Lecquereusia spiralis* Ehrenberg; \times 272. From Lake Hakone.
 Variations of the species common in Japan.
 The aperture is directed almost straight.
- Fig. 4, *Lequereusia modesta* Rhumbler; \times 225. From Lake Chuzenji.
 Fig. 5, *Diffugia bacilliarum* Perty; \times 225. From Lake Hakone.
 Fig. 6, *Diffugia elegans* Penard; \times 195.
 Very common. Individuals observed ranged from 60-194 μ in length.
- Fig. 7, *Quadrulella symmetrica* var. *curvata* Wailes; \times 427.
 Near the aperture the plates become small and irregular. Rarely observed. From Mt. Rokkozan.
- Fig. 8, *Nebela hippocrepis* Leidy; \times 198.
 Broad view of a shell. From Mt. Rokkozan.
- Fig. 9, *Nebela hippocrepis* Leidy; \times 198. Narrow view of same.
- Fig. 10, *Nebela triangulata* Lang; \times 325.
 Broad view of a shell. From Lake Hakone.
- Fig. 11, *Nebela triangulata* Lang; \times 378. From Lake Hakone.
 Fig. 12, *Nebela triangulata* Lang; \times 354. From Lake Hakone.
 Fig. 13, *Nebela triangulata* Lang; \times 315. From Lake Hakone.
 Fig. 14, *Nebela triangulata* Lang; \times 325. Narrow view of a shell. From Lake Hakone.
 Variation in the shape of the fundus and in the arrangement of the plates shown in these figures.
- Fig. 15, *Campascus dentatus*, sp. nov.; \times 370.
 Broad view of a shell with the posterior border of the fundus provided with numerous teeth-like prolongations. From Lake Hakone.
- Fig. 16, *Campascus dentatus*, sp. nov.; \times 390. Broad view of another shell. From Lake Hakone.
- Fig. 17, *Campascus dentatus*, sp. nov.; \times 390. Broad view of another shell. From Lake Hakone.
- Fig. 18, *Campascus dentatus*, sp. nov.; \times 390. Narrow view of same. From Lake Hakone.
- Fig. 19, *Paulinella chromatophora* Lauterborn; \times 1050. From Lake Hakone.